

Graphics Adapters

This chapter presents the PC 99 requirements and recommendations for graphics adapters.

The key design goal is to ensure that graphics hardware behaves consistently across a wide range of applications. Graphics-related issues for PC 99 are based on the need of the system to provide fast, high-quality graphics rendering. For example, applications that require 3-D graphics or advanced graphics applications such as computer-aided design (CAD) demand improved support in graphics hardware.

Requirements for MPEG and DVD playback, video input and capture devices, and display monitors are defined in the “Video and Broadcast Components” and “Monitors” chapters in Part 4 of this guide. Requirements for OpenGL support are defined in the “Workstation PC 99” chapter in Part 2 of this guide.

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System Requirements for Graphics Adapters

This section summarizes the PC 99 system requirements for graphics adapters.

Mobile PC Note

For exceptions and guidelines for the internal display on mobile PCs, see the “Mobile PC 99” chapter in Part 2 of this guide as well as notes in the individual sections of this chapter.

1. Graphics adapter uses PCI, AGP, or another high-speed bus

Consumer PC 99	Office PC 99	Entertainment PC 99
<i>Required</i>	<i>Required</i>	<i>AGP performance required</i>

Recommended: Pipelined Accelerated Graphics Port (AGP) attachment with optional sideband addressing and double-clocked data transfer mode.

Entertainment PC 99 systems must use AGP or an integrated graphics subsystem that meets or exceeds AGP performance levels. AGP technology allows for storing textures in system memory, allowing for larger, detailed texture maps in consumer applications. Also, effective AGP implementations can eliminate the need for a local memory texture cache. See the related changes to AGP requirements later in this section.

Note: It is anticipated that AGP or an integrated graphics subsystem that meets or exceeds AGP performance levels will be required for all system types in the next release of the design guide. The *Accelerated Graphics Port Interface Specification, Revision 2.0* is available at <http://developer.intel.com>.

In all cases, PCI adapters can be used as secondary graphics adapters.

2. System provides hardware-accelerated 3-D graphics

Consumer PC 99	Office PC 99	Entertainment PC 99
<i>Required</i>	<i>RequiredRecommended</i>	<i>Required</i>

Mobile PC Note

Except for Office PC 99 and Mobile PC 99, all system types must provide hardware-accelerated 3-D graphics. For most systems, support is provided using DirectX. All graphics adapter requirements related to 3-D hardware must be met except as noted in the section on 3-D hardware acceleration in this chapter and in *PC 98 System Design Guide*.

Office PC 99 systems designed as Windows NT graphics workstations must provide a 3-D accelerator that supports ~~both either~~ OpenGL and or Direct3D acceleration. Support for Direct3D on OpenGL accelerators is recommended for Windows NT 5.0. Windows NT OpenGL support can be implemented as a Mini Client Driver (MCD) or Installable Client Driver (ICD). OpenGL driver support for Windows 98 is optional and can only be implemented as an ICD.

3. System uses WC with higher-performance processors

<i>Consumer PC 99</i>	<i>Office PC 99</i>	<i>Entertainment PC 99</i>
<i>Required</i>	<i>Required</i>	<i>Required</i>

Write combining (WC) of successive stores to the frame buffer is a requirement for systems that use Pentium Pro and Pentium II or compatible processors.

4. Primary graphics adapter works normally with default VGA mode driver

<i>Consumer PC 99</i>	<i>Office PC 99</i>	<i>Entertainment PC 99</i>
<i>Required</i>	<i>Required</i>	<i>Required</i>

The default video graphics array (VGA) driver is required for installing the operating system, and the primary adapter must support 4-bit planar VGA mode as described in the Windows DDK. Secondary adapters in multiple monitor configurations do not need to provide VGA compatibility.

5. Adapter and driver support multiple adapters and multiple monitors

<i>Consumer PC 99</i>	<i>Office PC 99</i>	<i>Entertainment PC 99</i>
<i>Required</i>	<i>Required</i>	<i>Required</i>

System expansion buses that allow graphics adapters such as PCI and AGP can support the simultaneous use of more than one graphics adapter in the system. Each graphics adapter can support one or more attached monitors, but this is not a requirement. Although only a single AGP device can be implemented in a system, multiple-monitor support can be implemented using add-on PCI graphics adapters.

The device drivers for each graphics adapter must provide the required support to allow the presence of multiple adapters and multiple monitors. The hardware and BIOS support consist of Plug and Play-related configuration and resource requirements that ensure automatic support for use of more than one graphics adapter and for simultaneous display on two or more monitors. For details, see the “Multiple-Adapter and Multiple-Monitor Support” section later in this chapter.

6. Adapter supports television output if system does not include large-screen monitor

<i>Consumer PC 99</i>	<i>Office PC 99</i>	<i>Entertainment PC 99</i>
<i>Recommended</i>	<i>Recommended</i> <u><i>Optional</i></u>	<i>Recommended</i>

Recommended: Support both NTSC and PAL output.

Support for television output is recommended for Entertainment PC 99 systems that do not include a large-screen entertainment monitor. The ability to connect to and use a standard NTSC or PAL television as a large display surface is key to the ability to deliver realistic television, movie, and game experiences.

Mobile PC Note

For mobile PCs, television-output capabilities can be used to enable on-screen presentation graphics in the conference room.

Recommended: Composite, S-Video, and component outputs are provided. Component outputs are especially important in Europe and will become important in North America in the PC 99 time frame. All three cases can be supported by using three RCA connectors and the appropriate adapter cables.

The use of a second display controller to drive the television output is recommended. This allows a separate pixel surface, which is supported under Windows NT and Windows 98. In a home environment, a second display controller can allow the PC in the den to drive its monitor at 75 Hz for word processing while at the same time displaying a DVD movie or broadcast program on the television in the family room at 60 Hz.

The NTSC system must support 640×480 at 60 Hz. The PAL system must support 640×480 and 800×600 at 50 Hz. For information about the related requirements, see the “PC 99 Television Output Requirements” section later in this chapter. This recommendation might become a requirement in the future for Consumer PC systems.

. For information about requirements for large-screen monitors, see the “Monitors” chapter in Part 4 of this guide.

Graphics Adapters Basic Features

This section defines basic PC 99 feature requirements for graphics adapters.

7. Adapter meets PC 99 general device requirements

Required

This includes the PC 99 requirements for a Plug and Play device ID, automated software-only settings for device configuration, device drivers and Windows-based installation, and icons for external connectors. For more information, see the “Basic PC 99” chapter in Part 2 of this guide.

8. Screen resolution and local memory capacity meet PC 99 minimum requirements

Consumer PC 99

Office PC 99

Entertainment PC 99

Required

Required

Required

Recommended: $1024 \times 768 \times 24$ bpp and $1280 \times 1024 \times [8, 15, 16, 24]$ bpp.

The adapter must support all VESA standard timings for all PC 99 required resolutions, including $640 \times 480 \times [8, 15, 16, 24]$ bpp, $800 \times 600 \times [8, 15, 16, 24]$ bpp, and $1024 \times 768 \times [8, 15, 16]$ bpp. The following resolutions are recommended: $1024 \times 768 \times 24$ bpp and $1280 \times 1024 \times [8, 15, 16, 24]$ bpp

Mobile PC Note

For a mobile PC’s external display support, the graphics subsystem must support the PC 99 requirements defined in this chapter. For a mobile PC’s internal display, see the requirements in the “Mobile PC 99” chapter in Part 2 of this guide.

All PC 99 systems (except Office PC and mobile PC built-in displays) must provide sufficient video memory to support is $800 \times 600 \times 16$ bpp, double-buffered, with 16-bit Z buffer, and a 1.25-MB local-texture cache. On AGP systems that implement GART, the local texture cache can be implemented using non-local video memory.

Mobile PC Note

Note: For Mobile PC systems that support 3-D rendering using a chip set with integrated video memory that cannot meet these requirements, the minimum required resolution is $640 \times 480 \times 16$ bpp, double-buffered with Z buffer. No local texture cache is required. AGP is recommended for mobile systems.

For future 3-D titles, the high triangle content will make increased demands on graphics bandwidth. High-performance designs for systems such as Entertainment PC 99 or Consumer PC 99 that will support Direct3D applications should provide sufficient 3-D texture access to meet the 3-D performance recommendations defined in the item “Hardware meets PC 99 3-D accelerator performance requirements” later in this chapter.

Texture compression can provide additional effective texture memory, and it also increases the effective memory bandwidth that is available.

Note: When the user selects 1024×768 resolution, by default the graphics adapter must use a non-interlaced refresh rate. A graphics adapter can default to 1024×768 interlaced mode in either of the following situations:

The attached monitor is not DDC-compatible and the user has not selected a monitor type in the display control panel.

The monitor does not support 1024×768 non-interlaced mode, as determined from the Extended Display Identification Data (EDID) or registry settings.

9. Adapter meets VESA specifications for ergonomic timing rates

Required

Recommended: 85 Hz for 1024×768 , non-interlaced.

The graphics adapter must support, at a minimum, the 75 Hz ergonomic timings documented in the current version of *VESA and Industry Standards and Guidelines for Computer Display Monitor Timing* for all resolutions up to $1280 \times 1024 \times 768$ that are supported by the monitor. The minimum required support is 75 Hz for 1024×768 , non-interlaced. Higher scan-timings rates and resolutions are preferable under standards published by VESA.

Note: When the user selects 1024×768 resolution, by default the graphics adapter must use a non-interlaced refresh rate. A graphics adapter can default to 1024×768 interlaced mode in either of the following situations:

- The attached monitor is not DDC-compatible and the user has not selected a monitor type in the display control panel.

- The monitor does not support 1024 × 768 non-interlaced mode, as determined from the Extended Display Identification Data (EDID) or registry settings.

10. All supported color depths are enumerated

Required

The driver and INF file must enumerate all modes supported so that applications can choose their preferred color depth. The driver and INF file must follow the following guidelines for enumeration:

- At a minimum For 16bpp, either 5:5:5 or 5:6:5 (or both) modes must be supported.
- If only 5:5:5 mode is supported, the driver must also enumerate this as 16-bpp mode. This is required because some applications only look for 16-bpp support and will run in 8-bit mode if they fail to find a 16-bit mode.
- If both 5:5:5 and 5:6:5 modes are supported, both modes are enumerated.

For each color depth supported, color ordering must be implemented as shown in the following list. Color ordering is shown in the following table from the most-significant bit (MSB) to the least-significant bit (LSB.)

Mode	Color ordering
15 bpp	1 undefined, 5 red, 5 green, 5 blue (URRR RRG GGG BBBBB)
16 bpp	5 red, 6 green, 5 blue (RRR RRG GGG BBBBB)
24 bpp	8 red, 8 green, 8 blue (RRRR RRRR GGG GGG BBBBB BBBBB)
32 bpp	8 undefined, 8 red, 8 green, 8 blue (UUUU UUUU RRRR RRRR GGG GGG BBBBB BBBBB)

Mobile PC Note

For exceptions and requirements for an external secondary adapter implemented on a mobile PC system, see the “Mobile PC Graphics Requirements” in the “Mobile PC 99” chapter in Part 2 of this guide.

11. Graphics operations use relocatable registers only

Required

VGA registers must not be used to perform graphics operations such as bit blting, palette setting, and pointer movement. The registers used for these graphics operations can be either I/O locations or memory-mapped locations, but must be relocatable. Normal system operation—except for system startup and mode setting—should never require use of base VGA registers.

DirectDraw and Direct3D functionality must be independent of VGA. This means that graphics require VGA only for initialization.

12. Adapter supports downloadable RAMDAC entries for image color matching

Required

For graphics adapters that support 24-bit or higher displays, downloadable RAM digital-to-analog converter (RAMDAC) entries should be included to perform gamma correction in hardware. This capability supports the related requirement to use VGA only for system initialization.

This capability is also one of the most frequently requested features from independent software vendors (ISVs). For example, it supports transition effects in Internet Explorer 4.0 and other applications.

Image color matching (ICM) uses this capability to ensure that gamma is correct in the monitor and that games applications use this for palette switches.

13. Adapter supports DDC monitor detection

Required

This requirement is based on the *Display Data Channel Standard, Version 3.0* (DDC), which defines the communication channel between the display and host system. The software can use this information to properly manage output to the various displays and to prevent the disabling of television output if no monitor is attached.

Mobile PC Note

Mobile systems are not required to support DDC detection of the display if the display is permanently attached and connected using an internal interface. Such systems must support DDC for the external interface port, however.

Hardware Acceleration for Video Playback

This section presents the PC 99 requirements for graphics adapters support for video playback.

14. Adapter supports video overlay surface with scaling

Consumer PC 99

Office PC 99

Entertainment PC 99

Required

Required

Required

The graphics adapter must be able to support a minimum of one off-screen video overlay surface that has following characteristics:

- **Size.** Support for 720×576 or larger.
To support the HD0 formats for DTV—notably 720p24—it is required to support 1280×720 on the Entertainment PC. This will also support the current European maximum of 720×576 .
- **Screen Resolutions.** The video overlay must be fully operative at a minimum screen resolution of 1024×768 at 60 Hz and color depths of 8 bpp and 16 bpp.

Mobile PC Note

For Mobile PC 99 systems, support for 800×600 is required.

Recommended: Full support at 1280×1024 , with color depths of 8, 16, 24, and 32 bpp.

- **Color formats.** The required formats include the following:
 - YUV 4:2:2 YUY2: A packed-pixel byte stream for every pixel in the order of Y1, U, Y2, V is required in both, the primary and secondary overlay surfaces.
 - YUV 4:2:2 UYVY: A packed-pixel byte stream for every pixel in the order of U, Y1, V, Y2 is recommended in both, the primary and secondary overlay surfaces.
 - YUV 4:2:0 YV12: A system-board byte stream for the entire plane in the order of Y plane, V plane, U plane is required in the secondary overlay surface when double-buffering is supported. If double buffering is not supported, YV12 support must be provided in the primary overlay surface.

Mobile PC Note

Mobile PCs that implement video playback features are not required to support YUV 4:2:0 color format.

The YUV color space and intensity range are defined by the ITU-R BT.601-4 standard (previously called CCIR-601), where U is CB and V is CR. These formats use less memory while maintaining high quality, and YUV is the native format for many image and video compression standards.

~~Support for the ATSC color format is also required, as defined in the ATSC DTV specification, available at <http://www.atsc.org>.~~

- **Scaling.** ~~Up/down/down scaling to any size window. is required. Down scaling is recommended.~~

For Entertainment PC, the scaling hardware for small shrink ratios and all zoom ratios must support interpolation using a minimum of ~~two~~three taps vertically and four taps horizontally; ~~four or five~~ vertical and ~~seven or eight~~ horizontal is preferred. Typically, the coefficients chosen will correspond to a “windowed” $\sin x/x$ function, but considerable art is required to achieve the best subjective picture quality.

To allow optimization, ~~it is recommended that~~ filter coefficients ~~should be~~ stored in a look-up table where the values are downloadable from the driver. In the case of shrinks greater than a 2:1 ratio, it is necessary to use a larger number of taps. This can be implemented by a variety of techniques—for example, putting fixed shrink factors such as a halving factor in series with the variable shrink factor specified earlier. When doing shrinks, great care is needed with the filter coefficients to minimize spatial aliasing.

It is necessary to attenuate the high-frequency components in the source by either pre-filtering or adjusting the interpolation filter characteristics. Spatial aliasing while shrinking must not perceptibly detract from the quality of the material presented to the user.

- The ability to shrink by a variable factor of up to 4:1 in 1-pixel increments is ~~recommended~~required.
- For zooming, the requirement is a factor of up to 1:8 in 1-pixel increments.

For video-enabled ~~Office PC, Consumer PC, and Mobile PC~~ systems, it is acceptable to use bi-linear vertical scaling—that is, only a filter with two vertical taps and ~~two~~four horizontal taps is required. Even for these systems, however, it is believed that considerable consumer and marketplace benefits will be gained by implementing the requirements defined for Entertainment PC 99.

Mobile PC Note

Mobile PCs that implement video playback features are not required to support scaling.

For video-enabled Office PC and Mobile PC systems, it is recommended to use bi-linear for both horizontal and vertical scaling. Even for these systems, however, it is believed that considerable marketplace benefits will be gained by implementing the requirements defined for Entertainment PC 99.

The scaling engine on Entertainment PC and DTV-enabled systems must be able to accept an input with a minimum rate of 480p60 (720 horizontal pixels) and 720p24 (1280 horizontal pixels).

Recommended: Additional independent and resizable overlays for support of picture-in-picture (PIP) video features and multiple video conferencing windows, as described in *PC 98 System Design Guide*.

15. Hardware supports VGA destination color keying for video rectangle

Consumer PC 99

Office PC 99

Entertainment PC 99

Required with DVD-Video

Required with DVD-Video

Required

This is a requirement for video overlays. The compositing of the video plane under the VGA plane with the VGA pixels must be independently controllable for each VGA pixel. This VGA destination color keying must function in all video modes, using either a specific color/color range (eg on 4-bit, 8-bit, 15-bit, and 24-bit SVGA modes) and/or additional alpha blending bits in the color plane bits (on 16-bit and 32-bit SVGA modes).

This color keying of the VGA will allow certain VGA pixels to be replaced by the underlying video pixels on a pixel-by-pixel basis. This feature enables VGA video overlays, controls, Windows pop-up menus, dialog boxes, and so on, and allows for irregular shaped graphics compositing. Color keying must also work at the same time as any vertical/horizontal scaling that is active for the underlying video.

16. Hardware supports alpha blending of two video streams to support DVD-Subpicture and enhanced ui required by data-enhanced television

Consumer PC 99

Office PC 99

Entertainment PC 99

Required with Video

Required with Video

Required

The DVD-Subpicture stream has 4 bits of alpha information per pixel that indicate how the subpicture should be composited with the main picture. Future data-enhanced television streams will also require alpha composited UI functionality with 8-bit control as currently provided by settop-boxes such as WebTV. With 8 bits, the translucency can be faded in and out. Full 8-bit alpha blending is important to the creative community.

It is a requirement that 4 bits of alpha blending be provided in any secondary overlay surface when in 32-bit mode (for example, ARGB8888). In other color modes it is acceptable in the PC-99 timeframe to synthesize the effect within the secondary overlay surface. This can be done using screen-door dithering via the overlay color key (or 1-bit alpha control) or by implementing 2 bits of alpha control for the translucency states of 0%, 33%, 67%, 100%, or by using other methods. It is likely that future versions of this guide will require full 8 bits of alpha control in all color modes within any secondary overlay surface.

17. Video port meets PC 99 specifications if present on graphics adapter

Consumer PC 99

Office PC 99

Entertainment PC 99

Required

Required

Required

All graphics adapters that use a video port connection or that enable end users to make such a connection to a video device are subject to this requirement.

The video port is a dedicated connection between video devices, such as an MPEG-2 decoder or NTSC/PAL/SECAM decoder, and the graphics adapter, either implemented as a hard-wired connection on the same board as the graphics adapter or implemented between separate devices using a cable connection.

PC 99 systems are required to use a video port connection for hardware DTV MPEG-2 decoders when they are implemented on separate cards. ~~VIP2.x is the recommended desktop video port cable bus.~~ It is not a requirement for DTV MPEG decoders that are sited on the graphics card.

NTSC/PAL/SECAM analog decoders and MPML MPEG decoders implemented on separate cards are allowed to route digital video over the PCI bus, provided great care is taken and the rate does not exceed 27 MB/s. Details about this implementation will be defined in the "Video and Broadcast Components" chapter in Part 4 of this guide.

It is expected that most implementations of graphics adapters will have a single MPEG decoder and possibly a single NTSC/PAL/SECAM decoder on the graphics card. The provision of a side port connector on the card allows additional decoders to be added.

For a graphics adapter that includes a video port, for MPEG-2 or otherwise, the following requirements must be met:

- **Accessibility.** The video port must be accessible directly from an on-board decoder. The video port must also be accessible from decoders on separate cards using a cable connection.
- **Autoflipping.** The video port must support automated overlay and video port buffer flip on video port Vsync.
- **IRQ.** The video port must generate an interrupt request (IRQ) when vertical synchronization (Vsync) occurs. The kernel-mode video transport component of DirectDraw 5.0 can use this IRQ to perform autoflips. This capability allows fields to be skipped by the video port and also prevents an irregular synchronization from overwriting its buffers. This also enables capture of video port and vertical blanking interval (VBI) data.
- **Driver.** The driver must support DirectDraw VPE, which provides a key element of video playback support in DirectX 5.0. This support, as documented in the DirectX 5.0 DDK, must be incorporated to ensure that the graphics adapter and video port take advantage of VPE capabilities in the operating system.

For more information, see the white paper on DirectDraw VPE and kernel-mode video transport at <http://www.microsoft.com/hwdev/devdes/>.

Recommended: The following hardware design guidelines are recommended to support high-quality video playback:

- **Maximum height.** The graphics adapter should support a register that limits the maximum height of the field that gets written into memory.
- **Separate pitch and start addresses.** The overlay and the video port should support separate pitch and start addresses. This allows the bob algorithm to be used while the video is interleaved, which makes switching between bob and weave modes possible.
- **Standard video port.** The VESA Video Port committee has standardized on VIP 1.1 and is working on VIP 2.x. The MPEG-2 and NTSC/PAL/SECAM decoder implementations that use a cabled side port connection from external cards must comply with the VIP 1.1 specification and should move towards VIP 2.x as soon as it becomes available.

For more information about requirements related to video ports, see the “System Requirements for Video and Broadcast Components” section of the “Video and Broadcast Components” chapter in Part 4 of this guide.

18. Adapter supports MPEG-2 motion compensation acceleration

Recommended

For products that use MPEG-2 software decoders, MPEG-2 motion compensation acceleration is recommended. Microsoft plans to support motion compensation acceleration under DirectX in 1998.

Specifically, this recommendation refers, but is not limited, to the following:

- Motion compensation of YUV 4:2:0 planar surfaces (versus YUV 4:2:2 packed pixel surfaces) to decrease system memory bandwidth requirements
- Full-precision motion compensation (for example, use 9 bits for an 8-bit signed error term) to prevent degradation of video quality
- Bus mastering of error terms and vectors to and from AGP memory (versus system memory) to increase memory bandwidth and CPU cache efficiencies

For more guidelines on MPEG-2 video performance and quality, see the “Video and Broadcast Components” chapter in Part 4 of this guide.

19. Adapter provides the ability to scan at the same frequency as the incoming video

Consumer PC 99

Office PC 99

Entertainment PC 99

Recommended

Recommended

Required

To minimize and even eliminate the dropped or repeated frames necessary for synchronization, it must be possible to set the refresh rate on the card to be the same as the video being displayed in the primary window. If the video is 59.94 Hz, then the PC refresh rate should be 59.94 Hz +/-0.025 percent. Dropped or repeated frames must not occur more frequently than once every 60 seconds when there is a stable video source.

Mobile PC Note

The 59.94 Hz requirement does not apply to LCD screen devices in the PC 99 time frame.

Typically, the best way of achieving this is with some form of genlocking using a phased-locked loop. This should have a long time constant (many seconds) to avoid problems with noisy signals and changing television channels. When the source is or has been unstable or if the source has been changed, then greater frame dropping or repeating is allowed for the first three minutes after the source becomes stable.

It is recognized that currently there is an inconsistency with the requirement to use VESA timings (which don't currently include 59.94). The requirement will not be enforced (ie should be taken as a recommendation) until this conflict has been resolved. It is anticipated that the conflict will be resolved and so hardware vendors are strongly advised to include the capability of switching to 59.94. Certainly 59.94 operation is essential for avoiding repeated frames (causing a jump every 17 seconds) which are very annoying for the viewer.

Multiple-Adapter and Multiple-Monitor Support

This section defines the PC 99 requirements for ensuring system support for multiple adapters and multiple monitors. This support ensures that if the user adds a second adapter, resources will automatically be available and the operating system can automatically manage multiple display adapters.

The actual implementation a user might employ could be one of the following:

- Multiple adapters added to the PC system
- A single adapter with a single controller supporting two monitors
- A single adapter with multiple controllers supporting multiple monitors
- Any combination of these scenarios

The support provided in both Windows and Windows NT requires multiple-adapter compatibility in both the graphics adapter and its driver. With this new multiple-adapter/multiple-monitor support, a single adapter that supports multiple monitors can display independent screen images. This support is beyond the current simultaneous display features of some mobile PCs, which simultaneously show the same Windows desktop on two monitors.

The operating-system support for multiple adapters and multiple monitors requires allowing any secondary graphics adapters to be enabled in VGA mode, thus requiring that VGA for the previous adapter be temporarily disabled.

The support for multiple monitors also assumes that for monitors attached to the same system, but showing different images simultaneously, the different displays might have differing X,Y resolutions, color depths, refresh rates, and display capabilities.

For technical details about implementing driver support for multiple adapters and multiple monitors, see the Windows NT 5.0 DDK.

20. Extended resources can be dynamically relocated after system boot

Required

To ensure Plug and Play for multiple-adapter/multiple-monitor capabilities, all non-VGA standard display resources (also known as extended resources, such as register sets and so on) must be capable of being dynamically relocated after system boot.

This is an extension of the “Graphics operations use relocatable registers only” requirement earlier in this chapter. It also is an addition to the “General Plug and Play Requirements” section later in this chapter.

21. VGA resources can be disabled by software

Required

A means must be provided to allow a driver to disable its adapter from decoding standard VGA addresses. The purpose of this is to ensure that the adapter is independent of all other graphics adapters in the system. The adapter must remain fully functional without the VGA addresses. See also the “Graphics operations use relocatable registers only” requirement earlier in this chapter.

Hardware Acceleration for 2-D Graphics

This section summarizes PC 99 guidelines related to 2-D DirectDraw graphics features, which can be implemented as hardware acceleration features.

All PC 99 systems require hardware acceleration for 2-D graphics. Individual items in this section are marked as required or recommended for each system type. Robust DirectDraw support is required to allow 3-D hardware accelerators to take full advantage of the DirectX architecture.

22. Frame buffer can be accessed directly by applications

Consumer PC 99

Office PC 99

Entertainment PC 99

Required

Required

Required

The visible frame buffers must be accessible. It must be possible for applications to perform direct frame buffer accesses at any time, even while asynchronous accelerator operations are being executed. Without this capability, drivers cannot support DirectDraw or Direct3D on Windows NT, and operations on Windows will not be fully robust.

Some hardware keeps the information in its frame buffers in a format that does not correspond to the linear format that is standard in DirectDraw, such as tiling the pixels to exploit the 2-D coherence of image data. If this is the case, the hardware must perform translations so that DirectDraw surfaces that are being accessed directly appear linear. The hardware performing this translation might be a limited resource, but it must be able to perform translations on at least seven DirectDraw surfaces simultaneously. Support for eight or more surfaces is recommended.

23. Adapter and driver support linear-mapped, low-resolution modes

Consumer PC 99

Office PC 99

Entertainment PC 99

Required

Required

Required

This is required for all PC 99 system types, including systems with LCD displays. All graphics adapters currently support linear-mapped low-resolution modes. There is minimal additional driver work to support this.

Decreasing the size of the frame buffer decreases the average polygon size and increases the frame rate for a given scene. These additional modes provide support for software rendering games and software Direct3D.

If low-resolution support is implemented in the hardware, the following low-resolution modes are required:

$320 \times 200 \times 16$ bpp	$320 \times 240 \times 16$ bpp	$640 \times 400 \times 16$ bpp
$320 \times 200 \times 8$ bpp	$320 \times 240 \times 8$ bpp	$640 \times 400 \times 8$ bpp

The following low-resolution modes are recommended:

$400 \times 300 \times 16$ bpp	$512 \times 384 \times 16$ bpp
$400 \times 300 \times 8$ bpp	$512 \times 384 \times 8$ bpp

Note: In Windows, low-resolution capabilities must not be defined in the registry so that they do not appear in the display control panel. In Windows NT, the control panel automatically filters out these modes.

24. Adapter supports transparent blter

<i>Consumer PC 99</i>	<i>Office PC 99</i>	<i>Entertainment PC 99</i>
<i>Required</i>	<i>Required</i>	<i>Required</i>
This is required for all PC 99 system types. There is no restriction on source size. A transparent blter can perform a blt with a source key transparent color. This assumes that the blter is asynchronous with the host processor.		

25. Hardware ~~provides support to prevent tearingsupports double buffering with no tearing~~

<i>Consumer PC 99</i>	<i>Office PC 99</i>	<i>Entertainment PC 99</i>
<i>Required</i>	<i>Required</i>	<i>Required</i>
This is required for all PC 99 system types and must be performed in synchronization with the VBI.		

The hardware must support a mechanism for ~~preventing swapping buffers without~~ visible artifacts such as “tearing.” The mechanism for doing this is at the discretion of the hardware designer, but it should support tear-free capabilities ~~double buffering~~ for both full-screen and non-occluded windowed applications.

~~Notice that the~~ BLTs must be performed in synchronization with the vertical scan line to avoid tearing. The ability to read the current scan line supports blting or writing to the screen without tearing. Also, in some contexts such as video playback, this support eliminates the need for the secondary overlay ~~a back~~ buffer.

For information about the upper limits of resolution to be supported, see the requirement, “Screen resolution and local memory capacity meet PC 99 requirements,” earlier in this chapter.

26. Hardware supports programmable blter stride

Consumer PC 99	Office PC 99	Entertainment PC 99
Required	Required	Required
This is required for all PC 99 system types as part of the required support for textures. A programmable blter stride ensures that Windows can use linear memory. A fixed stride forces Windows to use rectangular memory management, with all the related inefficiencies. It must be possible to specify different strides for the source and destination on blts.		

Hardware Acceleration for 3-D Graphics

This section summarizes guidelines related to Microsoft Direct3D technologies that can be implemented as hardware acceleration features. Supporting the items in this section can result in improved performance and improved memory use.

For all PC 99 systems, the graphics subsystem is required to support 3-D hardware acceleration. Support for 3-D graphics is required by mainstream business applications, educational, entertainment, and other applications including the Internet Explorer shell for both Windows 98 and Windows NT 5.0.

27. Hardware supports PC 99-required RGB rasterization

Consumer PC 99	Office PC 99	Entertainment PC 99
Required	Required	Required
In RGB mode under Direct3D, shading across a surface is accomplished by independently interpolating all color components. The following capabilities are required for red-green-blue (RGB) rasterization:		

- Support 800 × 600 × 16 bpp, double buffered, with 16-bit Z buffer at 75 Hz in full-screen, 3-D graphics mode.
- All required features available at the same time; for example, turning off specular highlights in order to enable fog is not acceptable.
- Flat and Gouraud shading.
- MIP-mapped textures.
- Bilinear or better filtered textures (rather than point-sampled), with perspective correction.
- Alpha blending, including support for the following modes defined for Direct3D in the DirectX 5.0 DDK:

Mobile PC Note

For exceptions and requirements for mobile PCs that implement 3-D hardware acceleration, see the “Mobile PC Graphics Requirements” in the “Mobile PC 99” chapter in Part 2 of this guide.

Required	Recommended
D3DBLEND_DESTCOLOR	D3DBLEND_BOTHINVSRCALPHA
D3DBLEND_INVDESTCOLOR	D3DBLEND_BOTHSRCALPHA
D3DBLEND_INVSRCALPHA	D3DBLEND_DESTALPHA
D3DBLEND_INVSRCOLOR	D3DBLEND_INVDESTALPHA
D3DBLEND_ONE	D3DBLEND_SRCALPHASAT
D3DBLEND_SRCALPHA	
D3DBLEND_SRCOLOR	
D3DBLEND_ZERO	

For source RGB alpha blending, transparent primitives are blended with the background, but the background transparency is not updated. This method provides good visual accuracy if there are not too many overlapping transparent objects.

- Depth-based fog of an arbitrary color, where depth is defined as distance perpendicular to the screen.
- Support for per-vertex fog. (See the recommendations for RGB rasterization features later in this section.)
- Conformance to Direct3D rasterization rules
- No requirement for edge anti-aliasing. (See the recommendations for RGB rasterization features later in this section.)
- Specular highlighting.

The Direct3D reference rasterizer in the DirectX 5.0 DDK supports all of these capabilities.

28. Hardware supports recommended RGB rasterization features

<i>Consumer PC 99</i>	<i>Office PC 99</i>	<i>Entertainment PC 99</i>
<i>Recommended</i>	<i>Recommended</i>	<i>Recommended</i>

The recommended RGB rasterization features include the following:

- Range-based and table-based fog
- Hardware support for triangle strips and fans
- Sort independent edge anti-aliasing
- Precision line drawing (Bresenham line drawing algorithm recommended)

29. Hardware supports multi-texturing

Consumer PC 99

Office PC 99

Entertainment PC 99

Recommended

Recommended

Required

Multi-texturing hardware can apply multiple textures to a polygon. The common application of multi-texturing is map-based techniques for diffuse lighting and specular reflections.

To implement this capability, support is required for two or more sets of independent texture coordinates. It is recommended that hardware support the combining of at least two textures in a single pass.

The following texture combination operations are required:

- MODULATERGB: Component-wise multiplication of both texture colors
- MODULATELPHA: Multiply colors of one texture by the alpha of the other
- ADD: Component-wise addition of both textures
- BLEND: Linear combination of textures weighted by a scalar specified in a register or in a polygon alpha

Multi-texturing is used to compute the texture value that participates in the pixel pipeline implemented in Direct3D in DirectX 5.0. It is independent of the alpha blending stage that has existed in Direct3D since its inception.

This technique should work in combination with fog and alpha blending, but need not operate at the same time as other advanced filtering.

For more information, see the paper on multi-texturing and DirectX available on the web site at <http://www.microsoft.com/hwdev/devdes/>.

30. Hardware supports texture formats

Consumer PC 99

Office PC 99

Entertainment PC 99

Required

Required

Required

For PC 99 hardware that implements 3-D acceleration, the hardware must support palletized textures. Pallet entries use the corresponding nonpalletized formats shown in the following table.

Required

8-bit palletized

1:5:5:5 ARGB

4:4:4:4 ARGB

Recommended

4-bit palletized

8:8:8:8 ARGB

0:5:6:5 ARGB

4:2:2 YUV

31. Hardware complies with texture size limitations

<i>Consumer PC 99</i>	<i>Office PC 99</i>	<i>Entertainment PC 99</i>
-----------------------	---------------------	----------------------------

<i>Required</i>	<i>Recommended</i>	<i>Required</i>
-----------------	--------------------	-----------------

MIP mapping requires that textures of size 1×1 be supported. To meet PC 99 requirements, a 3-D accelerator must support this lower limit on texture size.

The texture units must support square and non-square power-of-two textures ($2^n \times 2^m$) up to 256×256 .

Recommended: The texture unit should support non-power-of-two width and height. This enables the texture mapping unit to be used to emulate blts. Also, it is recommended that the texture unit support an upper limit of 2048×2048 rather than the required 256×256 .

Mobile PC Note

This capability is not required for mobile PCs that implement 3-D hardware acceleration.

32. Hardware supports destination RGB alpha blending

<i>Consumer PC 99</i>	<i>Office PC 99</i>	<i>Entertainment PC 99</i>
-----------------------	---------------------	----------------------------

<i>Recommended</i>	<i>Recommended</i>	<i>Recommended</i>
--------------------	--------------------	--------------------

For destination RGB alpha blending, primitives are blended with the background, updating not only the colors in the frame buffer but also a cumulative transparency that can affect the rendering of subsequent primitives.

33. Hardware supports Z comparison modes and Direct3D-compatible formats

<i>Consumer PC 99</i>	<i>Office PC 99</i>	<i>Entertainment PC 99</i>
-----------------------	---------------------	----------------------------

<i>Recommended</i>	<i>Recommended</i>	<i>Required</i>
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It is required for Entertainment PC 99 systems and recommended for other system types that 3-D hardware support 16-bit minimum, unsigned, lockable Z buffer format and all Z comparison modes.

Hardware that supports Z buffering must support clearing of the Z buffer through the DirectDraw depth-fill blt mechanism. However, DirectX 5.0 enables Z buffers to be cleared at the same time as destination surfaces. It is recommended that PC 99 hardware support simultaneous clearing of color and Z buffers using the DirectX 5.0 mechanism.

34. Hardware meets PC 99 3-D accelerator performance requirements

<i>Consumer PC 99</i>	<i>Office PC 99</i>	<i>Entertainment PC 99</i>
-----------------------	---------------------	----------------------------

<i>Recommended</i>	<i>Recommended</i>	<i>Required</i>
--------------------	--------------------	-----------------

These performance capabilities are required for Entertainment PC 99 systems and recommended for other system types.

The 3-D rendering subsystem should have triangle setup capability implemented in hardware that is capable of processing triangles at a sustained rate in excess of

1 million triangles per second. Each triangle is assumed to be 1 visible pixel in area, front facing, textured, and composed of three vertices, where each vertex contains a diffuse and specular color component. Rendering conditions should be 16 bpp, bilinear textured, Z buffered, and alpha blended. Triangles should be ordered such that the Z check always passes (that is, the current triangle is in front of all previously rendered triangles).

The 3-D rendering subsystem should be capable of filling triangles at a sustained rate in excess of 40 million pixels per second. Each triangle is assumed to be 10,000 visible pixels in area, with the same attributes as described for triangle setup in the previous paragraph. Rendering conditions are also the same as for triangle setup. Supporting 60 million pixels per second is recommended.

PC 99 Television Output Requirements

This section summarizes the key design issues and requirements for television output capabilities, which are recommended for all PC 99 system types, including any Entertainment PC 99 system that does not include a large-screen entertainment monitor.

The requirements in this section apply only if the television output capability is present on a PC 99 system or on a graphics adapter that supports television output capabilities. Some television output capabilities listed in this section are required for Entertainment PC 99 only.

The required support allows an NTSC or PAL television to be used as a primary or secondary display surface for the Windows operating system and for Windows-based applications. Such a display surface allows more realistic game, video, and multimedia experiences for users who want to use a large-screen television that they already own.

It is hoped that now that the operating systems support it, many implementers will choose to use a separate TV resolution display controller for driving the NTSC encoder (typically on the same graphics adapter). The advantages are as follows:

- Provides a larger pixel working area.
- Ensures that the PC in the den can be used for word processing with a monitor running at 75 Hz while it also drives the television in the family room with a DVD movie or TV programs at 60 Hz.
- Provides support that is ideal for editing home videos, allowing the user to view the content and the edit time lines simultaneously.
- Eliminates the need for the user to continuously change the display resolution between the high-resolution, high-refresh rate needed for PC applications and the low-resolution, television-resolution mode.
- Eliminates the PC monitor flicker that occurs if the monitor is driven by the same display controller as the TV.

The TV resolution display adapter should be relatively inexpensive to implement, because it is low resolution and only needs to operate at relatively low speeds. The encoder may be on the same chip as the secondary display controller.

If television output capabilities are provided in a PC 99 system, support is required for either NTSC or PAL standards. NTSC refers to the television standards first developed in the United States and used in Canada, Japan, and Mexico. PAL refers to the television standards first developed in Germany and used in Austria, Belgium Brazil, Denmark, Finland, the Netherlands, Norway, Sweden, Switzerland, and the United Kingdom.

For more information about world television standards, see the web site at http://www.bbc.co.uk/aberdeen/eng_info/.

35. Adapter supports both NTSC and PAL output

Recommended

It is recommended that the television output adapter supports both output standards. If NTSC is supported, then the NTSC system must support 640×400 and 640×480 at 60 Hz. If PAL is supported, then the PAL system must support 640×480 and 800×600 at 50 Hz.

Whether either or both output standards are supported, software must be capable of independently enabling and disabling television and VGA output.

Note: For NTSC, the 60-Hz mode described in this section is actually 59.940 Hz.

36. Default boot mode supports appropriate locale

<i>Consumer PC 99</i>	<i>Office PC 99</i>	<i>Entertainment PC 99</i>
<i>Required</i>	<i>Required</i>	<i>Required</i>

PC 99 systems and graphics adapters must enable television output automatically as the primary display if a VGA monitor is not attached, defaulting to modes compatible with television output in the geographic region for which the adapter was localized. NTSC adapters should default to 60-Hz modes; PAL adapters should default to 50-Hz modes. Ideally, an adapter would support both modes and provide a safe means for the default selection to be changed by a user.

Mobile PC Note

For mobile PCs, it is acceptable for TV out to be enabled manually.

37. Adapter supports underscan scaling

<i>Consumer PC 99</i>	<i>Office PC 99</i>	<i>Entertainment PC 99</i>
<i>Required</i>	<i>Recommended</i>	<i>Required</i>

For Consumer PC 99 and Entertainment PC 99 systems, the television output adapter must be able to correct horizontal and vertical overscan using hardware scaling. This allows 640×480 resolution modes to fit onto NTSC displays and 800×600 resolution modes to fit onto PAL displays.

Driver software must be capable of enabling and disabling scaling and also of adjusting scaling for compatibility with a variety of television monitors. As television monitors age, overscan reduces, so less scaling is required.

38. Adapter supports flicker filter

Required

The television output adapter must use multi-line (3-tap minimum) hardware filtering techniques for flicker reduction. Enable, disable, and adjust capabilities for the flicker filter must be software controllable. Also, overscan should be software-enabled when the PC is playing full-screen video.

Mobile PC Note

For mobile PCs, the television output adapter must use 2-tap minimum hardware filtering techniques.

39. Adapter provides proper termination

Required

Proper termination is required so that optimal picture quality from any connector does not require displays to be attached to other connectors. For example, a VGA monitor must not be required in order for the S-Video output to appear properly.

40. Adapter supports composite video and S-Video connectors

Consumer PC 99

Office PC 99

Entertainment PC 99

Recommended

Recommended

Required

Compared to composite video, S-Video dramatically improves the picture quality of the NTSC or PAL scan converter. This standard is designed to reduce cross talk between chrominance and luminance signals and to increase the luminance bandwidth capability of the television. A further increase in quality is obtained by using component video. Component video is common in Europe and will become so in North America. For a description of these standards, see http://www.bbc.co.uk/aberdeen/eng_info/. Support for composite video and S-Video is required on Entertainment PCs and recommended for Consumer PCs.

~~The use of three connectors and the appropriate adapter leads, together with the necessary encoder hardware design and control software, allows all three formats to be accommodated at low cost without taking too much card front-panel space. For composite-only, one connector is used. For S-Video, two connectors are required. For component video, all three connectors are required.~~

A SCART (also called Peritel) connector can be supported for European markets by supplying the appropriate adapter lead to connect to the three RCA connectors.

41. Adapter supports both VGA and television output

Required

Recommended: Simultaneous output to VGA monitor and television. With one display controller, this requires both to be using a 60-Hz, low-resolution format; hence, the use of two display controllers is recommended.

In addition to television output, the PC 99 system also must support VGA output to ensure that users with large-screen VGA monitors can use this output capability.

42. Software supports positioning

<i>Consumer PC 99</i>	<i>Office PC 99</i>	<i>Entertainment PC 99</i>
<i>Required</i>	<i>Recommended</i>	<i>Required</i>

Software must be able to program the television output hardware to position the television image in increments of 4 pixels horizontally and 4 scan lines vertically.

43. Software supports detection of television connection

<i>Consumer PC 99</i>	<i>Office PC 99</i>	<i>Entertainment PC 99</i>
<i>Required</i>	<i>Recommended</i>	<i>Required</i>

For Consumer PC 99 and Entertainment PC 99 systems, software must be able to read the television output hardware to detect whether a television is attached to S-Video or composite output connectors. (Detection of a VGA monitor is achieved using the separate DDC requirement for graphics adapters and monitors.)

This is required to allow the operating system and graphics drivers to correctly support display output during the startup sequence (for example, determining what resolution and refresh rate to use) and to allow the applications to adjust their user interfaces appropriately to the screen capabilities.

44. Analog video outputs such as NTSC output have copy protection on DVD-enabled platforms

<i>Consumer PC 99</i>	<i>Office PC 99</i>	<i>Entertainment PC 99</i>
<i>Required</i>	<i>Required</i>	<i>Required</i>

The use of an appropriate copythe MacroVision protection system is necessary to stop DVD disks from being played on the PC and then recorded on a VCR. Details for DVD are available from MacroVision at <http://www.macrovision.com>.

PC 99 Design for Graphics Adapters

This section summarizes requirements related to the PC 99 design initiatives defined in Part 1 of this guide.

Plug and Play and Bus Design for Graphics Adapters

The items in this section summarize PC 99 requirements for Plug and Play and other resource-related and bus-related capabilities. The specifications in this section are required for all PC 99 systems.

Note: See also the “Graphics operations use relocatable registers only” requirement in the “Graphics Adapters Basic Features” section earlier in this chapter.

General Plug and Play Requirements

The requirements in this section ensure easy configuration.

45. Each device has a Plug and Play device ID

Required

The device must have a unique device ID using the format required for its bus. For example, a PCI device must comply with PCI 2.1² and also must provide a Subsystem ID and Subsystem Vendor ID, as defined in the “PCI” chapter in Part 3 of this guide.

Note: Multiple-monitor support allows Display class devices to be initialized independent of the system initialization process. For this reason, system-board and add-on display devices cannot use the VGA BIOS POST routine to populate the Subsystem Vendor ID because the device’s POST code might not be executed until later in the process, after device enumeration occurs. For system-board devices, the system BIOS should populate the Subsystem Vendor ID at power on. Add-on display adapters should provide a method for populating the Subsystem Vendor ID at the point when power is applied and the device is initialized to the state that is ready for POST.

46. System supports conflict resolution, VGA compatibility, and extended registers

Required

When the end user changes or adds a graphics adapter to the system, setting resource assignments must not require changing jumpers or switches on either the card or the system board. The system must be able to automatically relocate the resources used by a graphics adapter on the system board when a graphics adapter expansion card is added to the system. In the event of an irreconcilable conflict with other devices on the system, the system must be able to disable one of the adapters in order to prevent the system from stalling.

The system must support the VGA graphics standard for application compatibility and for the Windows clean-boot error-recovery process. If a VGA BIOS exists on the graphics adapter, it must be able to configure its base address to C0000h and one alternate address (minimum) to prevent conflicts.

Extended resources are additional I/O ports, direct-access frame buffers, or data transfer areas on a graphics adapter that use more resources than does standard VGA. The Windows configuration manager must be able to map the resources to avoid conflicts with other system devices. At least one alternate configuration must be provided for each non-VGA display resource in the event of conflict during the IPL boot.

The software drivers and VGA BIOS (if used) must be able to use alternate configuration register addresses. The system must be able to dynamically disable or relocate VGA resources from C0000h. It must also be possible to re-enable these resources upon system reboot or reset.

For additional related requirements for multiple monitor support, see the “Multiple-Adapter and Multiple-Monitor Support” section earlier in this chapter.

BIOS and Option ROM Requirements for Graphics Adapters

The requirements in this section relate to BIOS support for graphics adapters.

47. Chips support linear packed-pixel frame buffer, relocatable above 16 MB

Required

Note: For DirectDraw, the graphics adapter’s chip set must support linear access to the frame buffer by the host.

Windows is optimized for a graphics adapter with a packed-pixel frame buffer at all supported resolutions. Memory-mapped packed-pixel frame buffers also provide a fast and simple interface between Windows and the graphics adapter. The Windows DIB engine provides a very fast display by writing directly to packed-pixel frame buffers, and this architecture requires that the hardware developer write only a small, simple device driver.

For optimized support with Windows, a linear packed-pixel frame buffer is required over a bank-switched frame buffer. Use 32-bit addresses to allow the linear frame buffer to be placed above the 16-MB ISA boundary, which enables a system to be populated with large amounts of RAM.

If memory or other resources conflict with the frame buffer being mapped into a linear address space, the page frame address can be used with minimal degradation of performance.

48. Option ROM supports DDC2B

Required

This requirement does not apply for systems that use RISC-based processors. The option ROM for the graphics adapter must meet current DDC2B host requirements documented in *Display Data Channel Standard, Version 3.0*, published by VESA. This standard defines the functions that support the data channel between the graphics adapter and a DDC-compliant monitor.

49. BIOS setup utility provides option to force use of system-board graphics

Recommended

The OEM should provide an option in the system BIOS setup utility to force the system-board graphics device to be used (that is, to ignore and leave disabled any PCI graphics adapters). This option would ensure that a user with a PCI hot-docking system is always able to undock, because the VGA device will be in the mobile unit.

50. BIOS supports large frame buffers for graphics adapters

Required

The BIOS must support large frame-buffer graphics adapters that have up to 256 MB of frame buffers.

AGP Requirements

This section defines the PC 99 requirements for AGP.

51. AGP meets PC 99 implementation guidelines

Required

The following are the PC 99 requirements for AGP cards:

- Compliant with PCI 2.12 software interface layers, including the PC 99 requirements for Subsystem ID and Subsystem Vendor ID.
- Compliant with *Accelerated Graphics Port Interface Specification, Revision 1.0* or later. This means the card has an AGP capability pointer with a working AGP capability structure that has the following characteristics:
 - A minimum request-queue depth of 1 DWORD (RQ value of 0).
 - A minimum speed of 2x. 1x is acceptable for Mobile PC 99.
 - A workable AGP_ENABLE.
- System implementation of a Graphics Address Remapping Table (GART) and support for non-local video memory is required for all system types except Mobile PC 99.
- Compliance with the *PCI Bus Power Management Interface Specification, Revision 1.0* or later, including the Configuration Space registers and the device state (Dx) definitions.

Mobile PC Note

Mobile PC Note

Requirements for PCI Graphics Adapters

The requirements in this section apply for graphics adapters that use the PCI bus.

52. PCI graphics device supports IRQ and correctly populates PCI BARs

Consumer PC 99

Office PC 99

Entertainment PC 99

Required

Recommended

Required

Proper IRQ support is necessary for optimal support of video playback. The display driver for Windows queries the actual device to find its register locations and so on. The PCI base address registers (BARs) must be populated correctly for this information to be correct in the registry.

On adapters that do not support IRQ, the Interrupt Pin Register (3Dh) should be zero (0).

53. PCI system-board graphics device is not hidden from Plug and Play enumeration*Required*

Some current implementations cause problems for supporting multi-monitor capabilities with system-board graphics devices. Some system vendors hide the system-board graphics adapter from the PCI bus when another graphics adapter is detected in the system. The system-board device must disable the PCI device rather than hiding it.

Power Management for Graphics Adapters

This section summarizes the specific power management requirements for graphics adapters.

54. Graphics adapter complies with device class power management reference specification*Required*

The *Display Device Class Power Management Reference Specification, Version 1.0* or later, provides definitions of the OnNow device power states (D0–D3) for display and graphics devices. The specification also covers device functionality expected in each power state and the possible wake-up event definitions for the class, if any. Power states D0 and D3 are required; D1 and D2 are optional for graphics adapters.

55. Graphics adapter complies with VBE/Core 2.0 extensions for power management*Required*

The *VESA BIOS Extension Standard/Core Functions 2.0* (VBE/Core 2.0) specification defines extensions to VGA ROM BIOS services for power management.

Device Drivers and Installation for Graphics Adapters

This section summarizes the requirements for graphics adapters. The specifications in this section are required for all PC 99 systems.

For additional related requirements for multiple-monitor support, see the “Multiple-Adapter and Multiple-Monitor Support” section earlier in this chapter.

56. Device drivers and installation meet PC 99 requirements*Required*

The manufacturer does not need to supply a driver for a device if the device passes PC 99 compliance testing using a driver provided with the operating system. If the manufacturer supplies a driver, then the requirements for device drivers and installation are defined in the “Basic PC 99” chapter in Part 1 of this guide. The basic requirements include driver support for unattended installation and Help file support if special driver parameters are used.

Note: For Windows, the display driver (.DRV) component that is loaded and called by the Windows Graphics Device Interface (GDI) is a Win16 module.

57. Driver does not bypass any Microsoft-provided system components

Required

The driver must not bypass or patch any Microsoft-provided system components. For Windows, this includes Gdi.exe, Kernel.exe, User.exe, Dibeng.dll, Mmsystem.dll, Ddraw.dll, D3d*.dll, and so on.

For Windows NT, this requirement applies for all files normally installed in the System32 directory, including but not limited to Win32k.sys, Ntoskrnl.exe, Gdi32.dll, User32.dll, and Mcdsrv32.dll.

58. Applications provided with device meet Win32 requirements

Required

Any Windows-based applications provided with the device must meet Microsoft requirements for software compatibility as defined in the Microsoft Platform SDK.

59. Driver supports dynamic color bit-depth change

Required

The graphics adapter must operate properly and must not fail when asked by the operating system to change the color depth.

Graphics Adapters References

The following represents some of the references, services, and tools available to help build hardware that is optimized to work with Windows operating systems.

Accelerated Graphics Port Interface Specification, Revision 1.2.0

<http://developer.intel.com>

ATSC DTV Specification

<http://www.atsc.org>

Design guidelines for DirectX, multiple-monitor/multiple-adapter support, and white paper on DirectDraw VPE and kernel-mode video transport

<http://www.microsoft.com/hwdev/devdes/>

Display Data Channel Standard, Version 2.0

VESA BIOS Extension Standard/Core Functions 2.0 (VBE/Core 2.0)

VESA and Industry Standards and Guidelines for Computer Display Monitor Timing

Specification for Video Interface Port, Version 1.1

Video Electronics Standards Association (VESA)

2150 North First Street, Suite 440

San Jose, CA 95131-2029

Telephone: (408) 435-0333

Fax: (408) 435-8225

<http://www.vesa.org>

Display Device Class Power Management Reference Specification, Version 1.0

<http://www.microsoft.com/hwdev/onnow.htm>

PCI Local Bus Specification, Revision 2.1~~2~~ (PCI 2.1~~2~~)

PCI Bus Power Management Interface Specification, Revision 1.0

Phone: (800) 433-5177

<http://www.pcisig.com>

Windows, Windows NT, and DirectX DDKs

MSDN Professional membership

World television and S-Video interface standards

http://www.bbc.co.uk/aberdeen/eng_info/

Checklist for Graphics Adapters

If a recommended feature is implemented, it must meet the PC 99 requirements for that feature as defined in this document.

Consumer PC 99	Office PC 99	Entertainment PC 99
1. Graphics adapter uses PCI, AGP, or another high-speed bus <i>Required</i>	<i>Required</i>	<i>AGP performance required</i>
2. System provides hardware-accelerated 3-D graphics <i>Required</i>	<i>Recommended</i>	<i>Required</i>
3. System uses WC with higher-performance processors <i>Required</i>	<i>Required</i>	<i>Required</i>
4. Primary graphics adapter works normally with default VGA mode driver <i>Required</i>	<i>Required</i>	<i>Required</i>
5. Adapter and driver support multiple adapters and multiple monitors <i>Required</i>	<i>Required</i>	<i>Required</i>
6. Adapter supports television output if system does not include large-screen monitor <i>Recommended</i>	<i>Optional</i>	<i>Recommended</i>
7. Adapter meets PC 99 general device requirements <i>Required</i>		
8. Screen resolution and local memory capacity meet PC 99 minimum requirements <i>Required</i>	<i>Required</i>	<i>Required</i>
9. Adapter meets VESA specifications for ergonomic timing rates <i>Required</i>		
10. All supported color depths are enumerated <i>Required</i>		
11. Graphics operations use relocatable registers only <i>Required</i>		
12. Adapter supports downloadable RAMDAC entries for image color matching <i>Required</i>		
13. Adapter supports DDC monitor detection <i>Required</i>		
14. Adapter supports video overlay surface with scaling <i>Required</i>	<i>Required</i>	<i>Required</i>
15. Hardware supports VGA destination color keying for video rectangle <i>Required</i>	<i>Required</i>	<i>Required</i>
16. Hardware supports VGA destination color keying for video rectangle <i>Required with Video</i>	<i>Required with Video</i>	<i>Required</i>
17. Video port meets PC 99 specifications if present on graphics adapter <i>Required</i>	<i>Required</i>	<i>Required</i>
18. Adapter supports MPEG-2 motion compensation acceleration <i>Recommended</i>		
19. Adapter provides the ability to scan at the same frequency as the incoming video <i>Recommended</i>	<i>Recommended</i>	<i>Required</i>
20. Extended resources can be dynamically relocated after system boot <i>Required</i>		

21. VGA resources can be disabled by software
Required
22. Frame buffer can be accessed directly by applications
Required *Required* *Required*
23. Adapter and driver support linear-mapped, low-resolution modes
Required *Required* *Required*
24. Adapter supports transparent blter
Required *Required* *Required*
25. Hardware provides support to prevent tearing
Required *Required* *Required*
26. Hardware supports programmable blter stride
Required *Required* *Required*
27. Hardware supports PC 99-required RGB rasterization
Required *Required* *Required*
28. Hardware supports recommended RGB rasterization features
Recommended *Recommended* *Recommended*
29. Hardware supports multi-texturing
Recommended *Recommended* *Required*
30. Hardware supports texture formats
Required *Required* *Required*
31. Hardware complies with texture size limitations
Required *Recommended* *Required*
32. Hardware supports destination RGB alpha blending
Recommended *Recommended* *Recommended*
33. Hardware supports Z comparison modes and Direct3D-compatible formats
Recommended *Recommended* *Required*
34. Hardware meets PC 99 3-D accelerator performance requirements
Recommended *Recommended* *Required*
35. Adapter supports both NTSC and PAL output
Recommended
36. Default boot mode supports appropriate locale
Required *Required* *Required*
37. Adapter supports underscan scaling
Required *Recommended* *Required*
38. Adapter supports flicker filter
Required
39. Adapter provides proper termination
Required
40. Adapter supports composite video and S-Video connectors
Recommended *Optional* *Required*
41. Adapter supports both VGA and television output
Required
42. Software supports positioning
Required *Recommended* *Required*
43. Software supports detection of television connection
Required *Recommended* *Required*

44. Analog video outputs such as NTSC output have copy protection on DVD-enabled platforms
Required Required Required
45. Each device has a Plug and Play device ID
Required
46. System supports conflict resolution, VGA compatibility, and extended registers
Required
47. Chips support linear packed-pixel frame buffer, relocatable above 16 MB
Required
48. Option ROM supports DDC2B
Required
49. Digital video interface
Recommended Recommended Recommended
50. BIOS setup utility provides option to force use of system-board graphics
Recommended
51. BIOS supports large frame buffers for graphics adapters
Required
52. AGP meets PC 99 implementation guidelines
Required
53. PCI graphics device supports IRQ and correctly populates PCI BARs
Required Recommended Required
54. PCI system-board graphics device is not hidden from Plug and Play enumeration
Required
55. Graphics adapter complies with device class power management reference specification
Required
56. Graphics adapter complies with VBE/Core 2.0 extensions for power management
Required
57. Device drivers and installation meet PC 99 requirements
Required
58. Driver does not bypass any Microsoft-provided system components
Required
59. Applications provided with device meet Win32 requirements
Required
60. Driver supports dynamic color bit-depth change
Required